PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Nonwoven Fabrics and Methods of Manufacturing the Same

We, CHICOPEE MANUFACTURING CORPORATION, a corporation organised under the laws of the State of Massachusetts, United States of America, of 501, George Street, New Brunswick, New Jersey, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly declared in and by the following statement: —

The present invention relates to nonwoven textile fabrics and to methods of manufacture thereof, and particularly to fibrous webs bonded with cellulosic binders, which binders have been reacted with a formaldehyde cross-linking compound.

The invention is of primary importance in connection with nonwoven fabrics composed of cellulosic fibers, no matter how produced; i.e., carded, air-laid, water-laid, and the like. One such nonwoven fabric is exemplified by a product disclosed in the Patent Specification No. 468,529 and sold under the Registered trademark "MASSLINN." Another nonwoven fabric suitable for use in this invention is a rayon and cotton web impregnated with cellulose regenerated from viscose and sold under the Registered trademark "VISKON."

Some of the so-called "MASSLINN" nonwoven fabrics composed of textile fibers, the major proportion of which are oriented predominantly in one direction, are described in greater particularity in Patent Specification No. 833,697.

Other nonwoven fabrics disposed at random and not predominately oriented in any one direction, are described in Patent Specifications Nos. 674,779 and 677,928. Other nonwoven fabrics are composed of fibers which were originally predominantly oriented in one direction but which have been reorganized and rearranged in predetermined designs and patterns of openings and fiber bundles, such as fabrics made by the process disclosed in Patent Specification No. 836,397.

Illustrative cellulosic binders are: cellulose regenerated from viscose, cuprammonium solutions, and the like, cellulosic derivatives such as the alkyl ethers and esters of cellulose and other water-sensitive cellulose analogs such as chitin.

It has been discovered that the wet strength and wet abrasion resistance of a cellulose bonded fabric may be increased by reacting it with a formaldehyde cross-linking compound. The concentration of the cross-linking compound in the impregnating solution must be very low in order that the treatment only or substantially only effects the bonds without undue degradation. The choice of catalyst and its concentration are also important in execution of the cross-linking. Cellulose bonded fabric treated in the manner disclosed herein has excellent launderability and wet abrasion resistance.

Elementary formaldehyde or compounds which decompose to liberate formaldehyde, or resins, usually nitrogenous, which contain formaldehyde in reactive form, may be employed in the practice of this invention. Particularly preferred for this purpose are water-soluble precondensates or low polymers of methylolurea, methylolmelamine and the like.

Many substances are known to catalyze the reaction of formaldehyde and cellulose. These are in general acidic substances, such as the common mineral acids, or substances which become acidic at the elevated temperature at which the reaction takes place; e.g., tartaric acid, lactic acid, boric acid, various sulfonic acids, oxalic acid, acetic acid, formic acid, salts such as ammonium thiocyanate, ammonium acid phosphate, ammonium chloride and the like.

In accordance with the invention, a bonded non-woven fabric having textile-like softness, drape, hand and superior wash-resistance,

comprises a web of overlapping, intersecting cellulosic fibres and a formaldehyde cross-linked cellulosic binder being distributed throughout said web and forming bonds between said fibres, said fabric having a formaldehyde content of from 0.1% to 0.8% based on the weight of the fabric, and the cellulosic fibres of said fabric being substantially unbound by formaldehyde.

Also in accordance with the invention, a method of forming a bonded non-woven fabric having textile-like softness, drape, hand and superior wash-resistance comprises: wetting a web of overlapping, intersecting cellulosic fibres, adhesively bonding the fibres with a cellulosic binder, impregnating the bonded web with from about 0.1% to 0.8% of formaldehyde, based on the weight of the fabric, in the presence of an acid catalyst for the reaction of cellulose and formaldehyde, and drying the impregnated web to formaldehyde cross-link the cellulosic binder, said catalyst being in a concentration such that the pH of the fabric is not more than 0.5 pH units less than the pH of the web just prior to impregnation with formaldehyde.

Although the inventive concept will be described in particular with reference to a specific cellulose binder, for example cellulose xanthate, such is merely for illustrative purposes and is not to be construed as limitative of the broader aspects involved.

As is well known in the art, cellulose xanthate is readily prepared by reacting carbon bisulfide with suitably aged alkali cellulose and dissolving the reaction product in dilute sodium hydroxide solution. The amount of regenerated cellulose, or cellulosic material added to the fabric may vary widely with the fabrics treated and the effects desired, but will usually be within the limits of a few tenths per cent to 10 to 15 per cent by weight or higher. After application of the cellulose xanthate, the cellulose is regenerated and by-products and excess reagents are removed by washing. This fabric may be dried by exposure to temperature of approximately 250° F. prior to the formaldehyde impregnation. However, in certain instances it will be desirable to impregnate the bonded web with a cross-linking compound prior to drying. In the impregnation steps the liquid pick-up may vary widely but usually will be between the limits of somewhat less than 75 per cent up to 200 per cent or higher.

The concentration of the formaldehyde in the finished fabric will lie within the range of from 0.1% to 0.8% by weight, depending on the structure and composition of the fabric, the finish desired, and other considerations. The preferred concentration of the formaldehyde in the finished fabric is from 0.15% to 0.6%. At formaldehyde contents below the lower limit, the protective action is insufficient for practical benefit. Upper limits of the range are set by the development of undesirable effects on the fabric. As the formaldehyde content is raised, the fabric first begins to lose water absorbency as the fibers themselves pick up the cross-linking agent. At further increases in formaldehyde content, the binder becomes brittle, and the fabric as a whole is damaged to the point of uselessness. The final formaldehyde content in the fabric is analyzed by a colorimetric measuring method based on the reaction of chromotropic acid with formaldehyde in concentrated sulphuric acid, as is well known in the art.

In the formaldehyde impregnation step, the catalyst concentration is also important. Generally low-catalyst concentrations should be used; but the concentration limits depend on the acid strength of the catalyst material. The concentration of the catalyst should not be more than the amount which lowers the pH of the cured fabric about 0.5 units. It is preferred that the catalyst concentration does not lower the fabric pH a significant or measurable amount. One of the catalysts for formaldehyde cross-linking is sulfuric acid, and when this is used in accordance with the present invention, the optimum catalyst concentration is about 0.05% (N/100), assuming 100% liquid pickup of the resin solution. At this solution pickup the range for the sulfuric acid catalyst is from about 0.025% to about 0.1% (N/200 to N/50). This normality range is higher than that desired when using a very strong acid catalyst such as hydrochloric; but lower than can be used for weak acids or acid salts, or materials which decompose on heating with acid reaction, such as magnesium chloride, ammonium thiocyanate, lactic acid, and the like. Concentrations of 0.5% by weight may be used when such catalysts are employed in accordance with this invention. When using a higher concentration of catalyst than that specified, the fabric is tendered and loses its strength; while if a smaller amount of the catalyst than that specified above is used, excessive amounts of unbound formaldehyde are present, which is inefficient and wasteful, and the free formaldehyde contaminates the air around the curing apparatus.

The cross-linking agent may be cured at conditions previously known in the art, such as exposure for two minutes in air at 350° F. However, in accordance with the present invention, cure conditions do not need to be as stringent as these prior art conditions; e.g., the cross-linking agent may be cured by exposure to temperatures on a heated can of about 310° F. for as little as about one-half minute or as much as about five minutes.

Instead of solutions or dispersions of cellulose xanthate, other solutions or dispersions from which cellulose can be regenerated or precipitated so as to become a permanent or substantially permanent part of the fabric, may

be employed in the practice of the invention, for example, cellulose in cuprammonium solution, or in certain quaternary solvents. In addition there are certain cellulose compounds, dispersible in and precipitatable as such from aqueous, or alkaline aqueous media, which can be similarly employed, e.g., cellulose ethers and esters of a suitable degree of substitution, such as the methyl, ethyl or propyl ethers and esters, and carboxymethyl and hydroxyethyl ethers of cellulose, and the like. The terms "dispersion" and "dispersed" as used in the present specification and claims are intended to include all of the foregoing, whether they be true solutions or colloidal dispersions. Those cellulosic materials generally applied in the arts in solution in organic solvents are unsuited for the purpose of the invention. As exemplary of this class of materials, nitrocellulose may be cited.

In describing the invention reference will be made to the accompanying drawings setting forth preferred embodiments thereof.

Figure 1 is an enlarged plan view of a portion of a nonwoven fabric bonded with wavy or sinuous continuous lines of binder agent extending substantially transversely across the nonwoven fabric and generally at right angles to the longitudinal axis thereof;

Figure 2 is an enlarged plan view of a portion of a nonwoven fabric bonded with discontinuous lines of binder agent extending substantially transversely across the nonwoven fabric and at right angles to the longitudinal axis thereof;

Figure 3 is an enlarged plan view of a portion of a nonwoven fabric bonded with continuous lines of binder agent extending angularly across the nonwoven fabric;

Figure 4 is an enlarged plan view of a portion of a nonwoven fabric bonded with discontinuous lines of binder agent extending angularly across the nonwoven fabric;

Figure 5 is an enlarged plan view of a portion of a nonwoven fabric bonded in a square pattern of intersecting parallel rows of circular binder areas;

Figure 6 is an enlarged plan view of a portion of a nonwoven fabric bonded in a diamond pattern of intersecting parallel rows of circular binder areas;

Figure 7 is an enlarged plan view of a portion of a nonwoven fabric bonded in a square pattern of intersecting parallel rows of square binder areas;

Figure 8 is an enlarged cross-sectional view of the portion of the nonwoven fabric illustrated in Figure 7, taken on the line 8—8 thereof;

Figure 9 is an enlarged front cross-sectional view of a portion of a nonwoven fabric bonded with areas of binder agent in the upper surface and areas of binder agent on the lower surface;

Figure 10 is an enlarged side cross-sectional view of the nonwoven fabric illustrated in Figure 9;

Figure 11 is an enlarged plan view of a portion of a continuously bonded nonwoven fabric.

In the preferred embodiments of the present inventive concept shown in the drawings, a portion of a carded, nonwoven textile fabric 10 is illustrated in Figure 1 wherein sinuous binder segments 12 extend generally transversely across the width of the nonwoven fabric 10. In this configuration, the wavy binder segments 12 (when considered in gross) are substantially at right angles to the so-called "machine-direction" or the long axis of the nonwoven fabric 10. It is to be appreciated, however, that if an isotropic nonwoven fibrous web made by air deposition or other techniques is employed, or if any non-oriented fibrous nonwoven fabric is used, the binder segments 12 may extend longitudinally of the length of the fabric, or in its so-called "machine-direction". The unbonded portions 14 which extend between the binder segments 12 are sharply marked and clearly defined. Such a binder pattern is suitable for oriented, non-oriented, or rearranged nonwoven textile fabrics. The binder segments 12 are diffused substantially completely through the nonwoven textile fabric 10 directly in straight lines from one surface of the fabric to the other surface, in the form of relatively soft and flexible, individually distinct open networks of bonded fibers. Figure 8 illustrates the directness and sharpness of the diffusion.

In Figure 2, a portion of a carded, nonwoven fabric 20 is illustrated wherein the binder segments 22 are discontinuous and appear as rectangular areas on the surface of the fabric 20. The binder segments 22 are spaced apart by gaps of unbonded portions 24. Again, it is to be realized that the discontinuous binder segments 22 may, if desired, extend along the long axis of the nonwoven fabric, rather than across the same, particularly in the case of non-oriented fibrous nonwoven fabrics. Such binder patterns are suitable for oriented, non-oriented, or rearranged nonwoven fabrics. Geometrically speaking, the binder segments 22 are substantially right rectangular prisms having a rectangular base and a rectangular upper surface, as shown in Figure 2, and substantially rectangular lateral faces which extend perpendicularly to the surfaces of the nonwoven fabric 20.

In Figure 3, a portion of a carded, nonwoven fabric 30 is illustrated wherein the binder agent is in the form of substantially straight, continuous binder segments 32, separated by unbonded portions 34, extending angularly across the width of the fibrous nonwoven fabric. As shown, the binder segments 32 and the unbonded portions 34 are at an angle of about 75° to the long axis of

the web. If desired, this angle may, of course, be decreased to as low as about 0°, particularly for non-oriented nonwoven fabrics.

Such a binder pattern is suitable for oriented, non-oriented, or rearranged nonwoven fabrics.

In Figure 4, a portion of a carded, nonwoven fabric 40 is illustrated wherein the binder segments 42 are discontinuous, extending angularly across the width of the fibrous nonwoven fabric. Unbonded portions 44 lie between and separate the discontinuous binder segments 42. As shown, the binder segments are at an angle of about 75° to the long axis of the web. If desired, this angle may be decreased to as low as about 0°, particularly in the case of non-oriented nonwoven fabrics. Such a binder pattern is suitable for oriented, non-oriented, or rearranged nonwoven fabrics. Geometrically speaking, the binder segments 42 are right prisms and may appear on the surface of the nonwoven fabric either as parallelograms or rectangles.

In Figure 5, a portion of a random-laid nonwoven fabric 50 is illustrated wherein the binder segments 52 form a square pattern of intersecting parallel rows of circular binder segments which are separated by an unbonded portion 54. The diameters of the circular binder segments are, of course, equivalent in width and spacing to the lines of binder segments previously described. That is, the diameters of the circular binders range from about 0.006 inch to about 0.050 inch and preferably from about 0.010 inch to about 0.040 inch, with from about 8 to about 30 binder segments per inch, and preferably from about 10 to about 24 binder areas per inch, as measured in the long direction of the nonwoven web. The inter-circular spaces 56 in the lines of binder areas are of the same order as previously described, namely, from about 0.006 inch to about 0.050 inch, and preferably from about 0.020 inch to about 0.040 inch. The inter-circular spaces 56 are preferably equal but are not necessarily so. Such a binder pattern is preferred for non-oriented nonwoven fabrics.

In Figure 6, a portion of a random-laid nonwoven fabric 60 is illustrated wherein the binder agent forms a diamond pattern of intersecting parallel rows of circular binder areas of segments 62, the diameter and the number of bonds per inch of nonwoven fabric as measured in the direction of the long axis of the web as well as the inter-circular distance 66, being within the ranges described in connection with the circular binder pattern of Figure 5. Such a binder pattern is preferred for non-oriented nonwoven fabrics.

In Figures 5 and 6 which are plan views, the binder areas or segments 52, 62 have been illustrated and described as circular. In reality, the binders are actually in the form of substantially right circular cylindrical networks of bonded fibers. The binder is diffused substantially uniformly throughout the binder segment and is not concentrated solely on the surface of the nonwoven fabric. As a result, the binder segments 52 and 62 are neither dense nor solid masses but are relatively soft and flexible and do not create a pebbly or nubby feel.

In Figure 7, a portion of a random-laid nonwoven fabric 70 is illustrated wherein the binder agent forms a square pattern of intersecting parallel rows of square binder segments 72 separated by an unbonded portion 74. The sides of the squares have lengths of from about 0.006 inch to about 0.050 inch and preferably from about 0.010 inch to about 0.040 inch. The number of binder areas per inch of nonwoven fabric measured along the long axis thereof ranges from about 8 to about 30 and preferably from about 10 to about 24 The inter-square distance 76 between the segments of binder may range from about 0.006 inch to about 0.050 inch and preferably from about 0.020 inch to about 0.040 inch. Such a binder pattern is preferred for non-oriented nonwoven fabrics.

In Figure 7 which is a plan view, the binder segments 72 have been illustrated and described as squares. In reality, the binders are actually in the form of substantially right square prism networks of bonded fibers, the cross-sections of the networks being substantially square from base to top surface. The binder is diffused substantially uniformly throughout the binder segment and is not concentrated solely on the surface of the nonwoven fabric. As a result, the binder segments 72 are relatively soft and flexible and do not create a pebbly or nubby feel.

In Figure 8, there is illustrated a cross-section of the portion of the nonwoven fabric 70 illustrated in Figure 7. It is to be observed that the binder segments 72 are substantially rectangular in cross-section and that they extend substantially completely through the nonwoven fabric from one surface to the other surface. In some cases, slight concavities have been observed in the upper and lower surfaces of the binder segments but these are relatively small and have no undesirable effect on the properties and characteristics of the nonwoven fabric.

The proportion of the weight of the binder material in the binder segments to the weight of the fibrous material in these binder segments is an important factor in determining the softness, drape and hand of the finished nonwoven fabric and of particular criticality with regard to the pebbly, nubby or pimply feeling. This proportion may be computed by a precise chemical analysis or more quickly with less accuracy by determining the amount of binder add-on in the binder segments from the weight of the nonwoven fabric before and

after bonding. The weight of the fibrous materials in these binder areas is the fractional coverage of the binder multiplied by the weight of the dry nonwoven web. In the foregoing embodiments of the invention, the per cent coverage is from about 10% to about 50%, and preferably from about 12% to about 35% of the dry nonwoven web.

The nonwoven fabrics which may be used in accordance with this invention may be bonded by any of the known methods of bonding such as impregnation, spray-bonding and applying the binder in spaced areas of the web by rotogravure techniques employing a preliminary step of wetting the fibrous web with from 70% to 250% by weight of an aqueous liquid, based on the weight of the dry web. The surface coverage of the fibrous web by the binder may range from about 1% to about 100%, but it is preferred that the surface coverage be at least about 10%. The amount of binder adds-on based on the weight of the fibrous web should be from about 0.3% to about 15%.

The finished fabrics of this invention will range from about 100 grains per square yard to about 2,000 grains per square yard, though it is preferred that the weight of the finished fabric be from about 175 grains per square yard to about 1,000 grains per square yard.

In Figures 9 and 10, there are illustrated cross-sections at right angles to each other of a portion of a nonwoven fabric 80 which is another embodiment of the invention. This nonwoven fabric has binder lines or areas 82 (Figure 9) which extend in one direction on the upper surface of the nonwoven fabric 80 and are separated by unbonded areas 84. Other binder lines or areas 86 (Figure 10) are disposed on the lower surface of the nonwoven fabric 80 and extend in a direction normal to the direction of binder lines 22. These latter binder lines 86 are separated by unbonded areas 88. It will be apparent from Figures 9 and 10 that the binder lines 82 and 86 have not diffused or penetrated uniformly or completely through the nonwoven fabric 80 and that they merely lie in parallel lines in each surface of the fabric to form intersecting overall parallel grid patterns. These patterns meet each other at the intersections 90 which are located approximately in the center of the nonwoven fabrics. The surfaces of the bonds 82 and 86 are hard and flat and create a nubby and pebbly feeling. Slight concavities are formed in the faces of the bonds 82 and 86 and impart a corrugated effect.

In Figure 11 which is an enlarged plan view, the binder 102 is diffused substantially uniformly throughout the nonwoven fabric 100, and tends to coat the fibers 104.

In order to facilitate a clear understanding of the invention, the following preferred specific embodiments are described in detail.

Example I

A dry all-rayon nonwoven fabric weighing 750 grains per square yard containing about 7% regenerated cellulose deposited in a fine-line pattern to function as a binder (as described below) is impregnated in a mangle with a solution containing 1% of an essentially monomeric methylolmelamine cross-linking agent (sold by American Cyanamid Company as Aerotex UM), and N/100 sulfuric acid. Solution pickup from the bath is about 100% based on the weight of the air dry nonwoven fabric. The fabric is rapidly dried in a tenter frame at 260° F. and cured in an oven by exposure to 350° F. temperature for two minutes. The bound formaldehyde content of the fabric is found by analysis to be 0.34%, occurring principally in the binder cellulose as determined by means of chemical staining tests.

After completion of the curing operation, the fabric is used as a wet-wiping cloth for dishes, counters, tabletops, walls, and for heavy duty use in washing automobiles. The treated and cured fabric shows a 5-fold increase in service life as compared to an analogous fabric which does not have the cross-linking treatment.

In a comparative test, the methylolmelamine monomer is applied from a 5% solution. Catalyst concentration is maintained at N/100 H_2SO_4. Bound formaldehyde content as determined by analysis is 1.7%. The fabric has poor absorbency and is very stiff and is not a desirable washcloth.

Example 2

The procedure of Example I is followed, except that the cross-linking agent is methylolurea (sold by Rohm & Haas as Rhonite 313), and the bound formaldehyde content is found by analysis to be 0.16%; and a fabric similar to that described in Example I is obtained.

In a comparative test, this example is repeated except that the cross-linking agent is methylolurea applied from 4% solution with N/25 H_2SO_4 as catalyst. The bound formaldehyde content is found by analysis to be 0.55%. After curing, the nonwoven fabric is badly tendered and unsuitable for use.

This example demonstrates the deleterious effect of raising the amount of acid catalyst used in the impregnation step. It should be noted that, in accordance with the present invention, the concentration of acid catalyst must be kept within the limits previously prescribed rather than maintaining a constant ratio of acid catalyst to formaldehyde as is often done in normal practice.

Example 3

The procedure of Example I is repeated, except that the cross-linking agent is a substituted methylol triazone (sold by Dan River under the trade name Stanset Z-98) and its bound formaldehyde content is found to be 0.29%; and similar results are obtained.

EXAMPLE 4

The procedure of Example I is followed, except that the base fabric to which the cross-linking agent is applied contains 100% cotton fiber; and similar results are obtained.

EXAMPLE 5

The procedure of Example I is followed, except that the base fabric contains a 50—50 blend of cotton and rayon fibers; and similar results are obtained.

EXAMPLE 6

The procedure of Example I is followed, except that the base fabric is composed of rayon fibers (sold by Courtaulds, Inc. under the trade name Corval) which are modified in their manufacture by reaction with formaldehyde donor cross-linking agents; and similar results are obtained.

EXAMPLE 7

The procedure of Example I is followed, except that the nonwoven fabric is rearranged in accordance with the process outlined in Patent Specification No. 836,397 prior to the cross-linking treatment; and similar results are obtained.

EXAMPLE 8

The procedure of Example I is followed, except that the cross-linking agent is formaldehyde applied from a 2% solution with N/100 H_2SO_4 catalyst. The bound formaldehyde content of the fabric is found to be 0.58% by chemical analysis. The product has the desirable properties as described in Example I.

EXAMPLE 9

The procedure of Example 2 is followed, except that the acid catalyst used is $MgCl_2$, at 1/2% concentration in the solution; and similar results are obtained.

EXAMPLE 10

The procedure of Example 2 is followed, except that the acid catalyst used is NH_4SCN (ammonium thiocyanate), at 1/2% concentration in the solution; and similar results are obtained.

EXAMPLE 11

The procedure of Example 2 is followed, except that the catalyst used is lactic acid, at 1/2% concentration in the solution; and similar results are obtained.

EXAMPLE 12

The procedure of Example I is followed, except that the base fabric is bonded with 7% water insoluble hydroxyethyl cellulose; and similar results are obtained.

EXAMPLE 13

A dry, all-rayon nonwoven fabric, made in accordance with the process outlined in Patent Specification No. 836,397, weighing 225 grains per square yard, containing about 2% regenerated cellulose deposited in the fine-line pattern (13 lines per inch), to function as a binder, is impregnated in a mangle with a solution containing 1% Aerotex UM, and N/100 sulfuric acid. Solution pickup from the bath is about 100% based on the weight of the air-dried nonwoven fabric. The fabric is cured by exposure to 350° F. for two minutes. The bound-formaldehyde content of the fabric is found by analysis to be 0.35%, occurring principally in the binder cellulose, as determined by means of chemical staining tests.

At the completion of the curing operation, the fabric is laundered eight times; it is essentially unchanged from the original fabric. A comparative fabric, without cross-linking treatment, shows pilling and considerable tearing after only five wash cycles

EXAMPLE 14

A dry all-rayon fibrous web weighing approximately 600 grains per square yard is bonded with regenerated cellulose uniformly distributed throughout the fibrous web so that the final nonwoven fabric contains about 8% binder. This nonwoven fabric is impregnated in a mangle with a solution containing 1% of essentially monomeric methylolmelamine cross-linking agent (sold by American Cyanamid Co. as Aerotex UM) and N/100 sulphuric acid. Solution pickup from the bath is about 200% based on the weight of the air dried nonwoven fabric. The fabric is dried by exposure to a temperature of 350° F. for two minutes. The bound formaldehyde content of the fabric is found by analysis to be 0.58% occurring principally in the binder cellulose as determined by means of chemical staining tests.

This fabric is used as a wrapping for cheese and similar foods. The treated and cured fabric withstands 20 washings without deleterious effect while an analogous fabric which has not undergone the cross-linking treatment, pills and loses fibers after only three washings.

EXAMPLE 15

A dry all-rayon nonwoven fabric weighing 750 grains per square yard, containing about 4% regenerated cellulose deposited in a fine line pattern (8 lines to the inch) to function as a binder, is impregnated and mangled with a solution containing 1-1/2% monomeric methylolmelamine cross-linking agent (sold by American Cyanamid Co. as Aerotex UM) and N/100 sulphuric acid. Solution pickup from the bath is about 200% based on the weight of the air dry nonwoven fabric. The fabric is dried by exposure to a temperature of 350° F. for two minutes. The bound formaldehyde content of this fabric is shown by analysis to be 0.75% occurring principally in the binder cellulose as determined by a chemical staining test.

After completion of the curing operation the fabric is used as a wet wiping cloth for dishes, counters, and the like. The treated and cured fabric withstands repeated washings very readily and is reasonably absorbent though after continued use it tends to smear when wiping smooth surfaces such as glass or mirrors.

In a comparative test, dry all-rayon nonwoven fabric weighing 750 grains per square yard, containing about 4% regenerated cellulose deposited in a fine-line pattern (8 lines to the inch) to function as a binder, is impregnated and mangled with a solution containing 2-1/2% of essentially monomeric methylolmelamine cross-linking agent (sold by American Cyanamid Co. as Aerotex UM) and N/100 sulphuric acid. Solution pickup from the bath is about 200% based on the weight of the air-dried nonwoven fabric. The fabric is dried by exposure to a temperature of 350° F. for two minutes. The bound formaldehyde content of this fabric is found by analysis to be 1.15% occurring principally in the binder cellulose as determined by a chemical staining test.

The resulting fabric is unsatisfactory as a wiping cloth as its absorbency is low and it smears readily when rubbed across smooth surfaces such as glass or a mirror.

WHAT WE CLAIM IS:—

1. A bonded nonwoven fabric having textile-like softness, drape, hand and superior wash-resistance, comprising a web of overlapping, intersecting cellulosic fibres and a formaldehyde cross-linked cellulosic binder being distributed throughout said web and forming bonds between said fibres, said fabric having a formaldehyde content of from 0.1% to 0.8% based on the weight of the fabric, and the cellulosic fibres of said fabric being substantially unbound by formaldehyde.

2. A fabric according to claim 1 in which the formaldehyde content of said fabric is from 0.15% to 0.6% based on the weight of the fabric.

3. A fabric according to claim 1 or 2 in which the binder is distributed throughout the web in a predetermined pattern of spaced binder segments in bonding relationship with the fibres passing through said segments, the formaldehyde cross-linking occurring substantially only in the cellulosic binder.

4. A fabric according to any of the preceding claims in which the fibres are bonded by a formaldehyde cross-linked regenerated cellulosic binder.

5. A fabric according to claim 3 in which the spaced binder segments cover from 12% to 25% of the lateral surface of the fabric.

6. A method of forming a bonded nonwoven fabric having textile-like softness, drape, hand and superior wash-resistance which comprises: wetting a web of overlapping, intersecting cellulosic fibres, adhesively bonding the fibres with a cellulosic binder, impregnating the bonded web with from about 0.1% to 0.8% of formaldehyde, based on the weight of the fabric, in the presence of an acid catalyst for the reaction of cellulose and formaldehyde, and drying the impregnated web to formaldehyde cross-link the cellulosic binder, said catalyst being in a concentration such that the pH of the fabric is not more than 0.5 pH units less than the pH of the web just prior to impregnation with formaldehyde.

7. A method according to claim 6 in which the fibres are adhesively bonded in a predetermined pattern of spaced binder segments.

8. A method according to claim 6 or 7 in which the web is adhesively bonded substantially throughout its entire thickness.

9. A method according to any of claims 6—8 in which the acid catalyst is an aqueous sulphuric acid solution having a normality of from N/200 to N/50.

10. A nonwoven textile fabric constructed and arranged substantially as hereinbefore described and shown in the accompanying drawings.

11. A method of forming a nonwoven textile fabric substantially as hereinbefore described.

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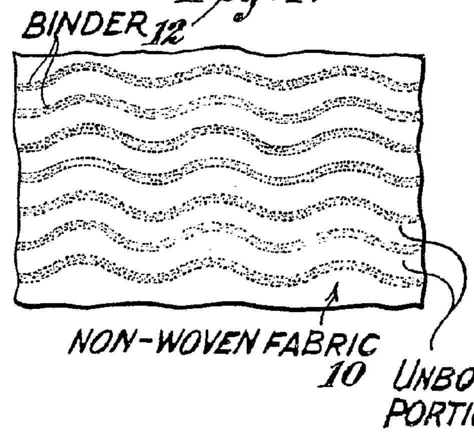
Fig. 1.



Fig

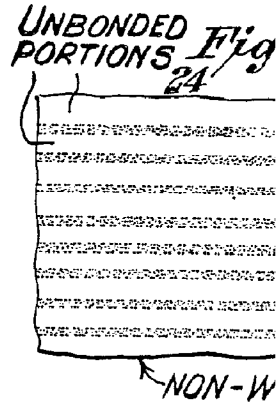


Fig. 3.

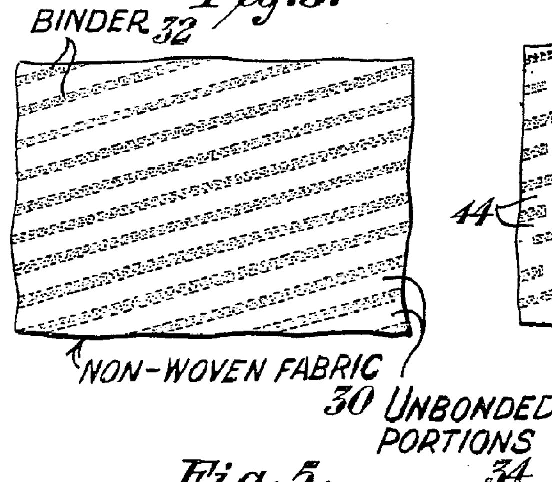


Fig.

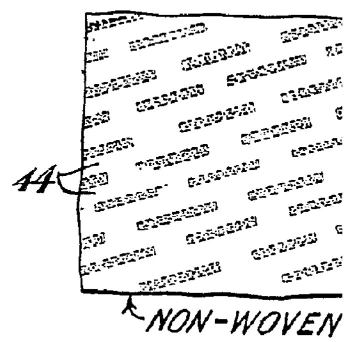
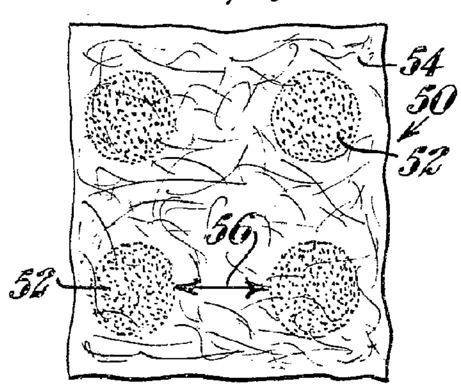
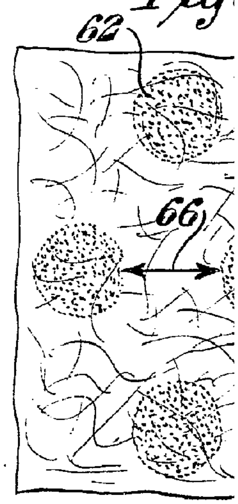


Fig. 5.



Fig



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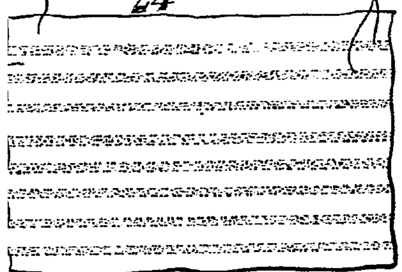

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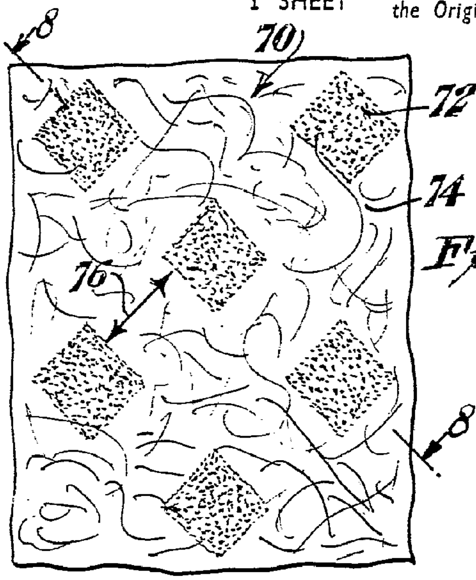

'D
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Fig.4.

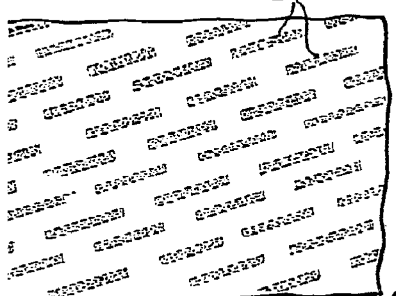
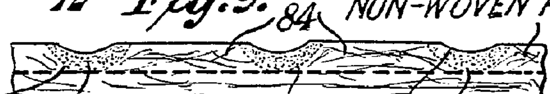


Fig.8.

Fig.9.



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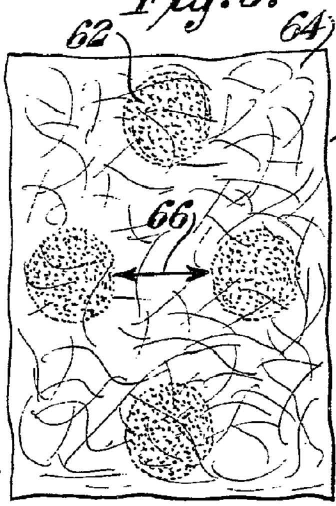


Fig.10.

Fig.11.

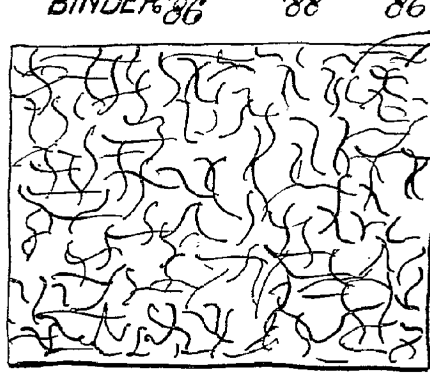


Fig. 1.

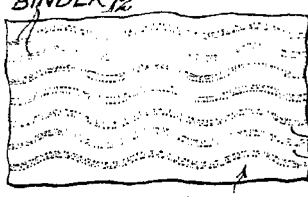
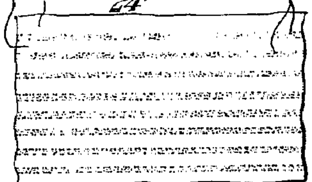


Fig. 2.



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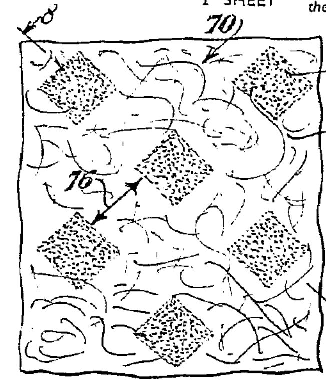

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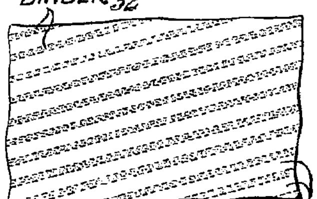

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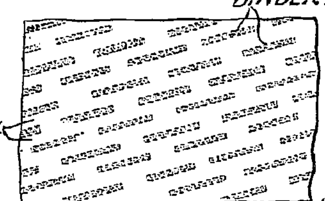
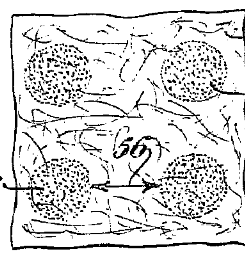


Fig. 8.

Fig. 9.

Fig. 10.

Fig. 5.



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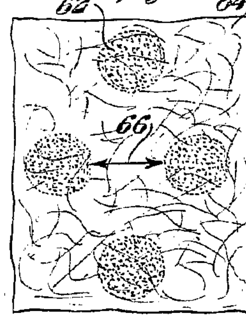

Fig. 11.